GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF RESEARCH ADMINISTRATION

Date: 11 March 1968

RESEARCH PROJECT INITIATION

Project Title: A Study of the With-In Bale Variability of Cotton and Research on an Improved Cotton Sample Blender

Project No.: B-1310

Project Director: Dr. J. W. McCarty

Sponsor: Cotton Producers Institute

Agreement Period: From 1 March 1968 until 31 December 1968

Type Agreement: Cooperative Agreement

Amount: $49,970 (An additional $14,000 is expected to be recovered through the sale of loose cotton)

Technical Administrator

Mr. Robert Cleaver
National Cotton Council of America
Box 12285
Memphis, Tennessee 38112

Reports Required

Monthly Progress - letter type, in quintuplicate

Quarterly - in quintuplicate

Final - upon completion of project, in quintuplicate

Notes: 1. Patent Agreement is required
2. Number and short title is "CPI 68-113 Sampling/Sample Blender"

Assigned to: School of Textile Engineering

COPIES TO:

- [X] Project Director
- [X] School Director
- [X] Dean of the College
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File B-1310

GEORGIA INSTITUTE OF TECHNOLOGY
A. FRENCH TEXTILE SCHOOL
ATLANTA, GEORGIA 30332

April 10, 1968

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MAY 1968
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Cotton Producer Institute
P. O. Box 12285
Memphis, Tennessee 38112

Attention: Mr. Robert Cleaver

Subject: Monthly Letter Report No. 1
CPI 68-113 (Our B-1310)

Dear Sir:

Part I, Phase I; A Preliminary Mass Sampling. The five bales of cotton to be studied in Phase I, including one bale from Augusta, Dallas and Memphis and two bales from Lubbock, were purchased. Three of the bales (two from Lubbock and one from Augusta) were received; sampled according to plan; and, the fiber tests begun. Because of delayed shipment, the bales from Memphis and Dallas did not arrive during the month as anticipated. It is expected that we will have these bales in time to complete this phase of the program prior to May 1.

Part I, Phase II; The Basic Program. With the help of the different offices of the Cotton Division, Consumer and Marketing Service, United States Department of Agriculture, the program of acquiring ten bales from each of nine areas from the cotton belt has proceeded quite rapidly. At the end of March none of these lots had been received, but word has been received from eight of the areas that the acquisition of the needed bales was going forward.

The bales from Bakersfield, California and Phoenix, Arizona were concentrated and ready for pick-up. Arrangements have been made for a carpet company truck to deliver these lots to the Atlanta warehouse. The Lubbock lot is about complete and will be delivered to Atlanta in the near future. The selection of the Dallas bales is complete but the different bales are so scattered over the area that instructions were given to have them sent individually to our Atlanta warehouse. The Memphis bales and the Greenwood bales are accumulated and the carpet company truck has been alerted to deliver those lots. The Montgomery lot and the Atlanta lot are not complete at this time. The Augusta lot is complete and should be arriving in Atlanta soon.

Part II, Cotton Sampler Blender. Very preliminary work has begun on this part of the program. The blender developed at Stanford was obtained from Clemson and moved to our laboratory for study. Some literature survey and study of previous work in the area has also been undertaken.

On March 18, 1968 the project directors, accompanied by Professor R. B. Belser, were in Memphis for conferences with National Cotton Council personnel regarding this and other projects.

Respectfully submitted:

J. W. McCarty
Project Director Part I

W. C. Boteler
Project Director Part II

Approved:

L. Taylor, Director
A. French Textile School

GEORGIA INSTITUTE OF TECHNOLOGY
A. FRENCH TEXTILE SCHOOL
ATLANTA, GEORGIA 30332

May 2, 1968

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Cotton Producer Institute
P. O. Box 12285
Memphis, Tennessee 38112

Attention: Mr. Robert Cleaver

Subject: Monthly Letter Report No. 2
CPI 68-113 (Our B-1310)

Dear Sir:

Part I, Phase I; A Preliminary Mass Sampling. The five bales of cotton to be studied in Phase I have now all been received. Three of the five bales are completely tested and the data has been processed through the computer. Data for bales four and five are almost ready to go to the computer. It is anticipated that all of this data will be analyzed soon so that the results can be discussed with CPI representatives and a decision regarding the sampling to be done in Phase II can be made.

Part I, Phase II; The Basic Program. The ninety bales of cotton to be acquired and studied in this phase of the program have all been obtained. We are indebted to the various offices of the Cotton Division, Consumer and Marketing Service, United States Department of Agriculture for their assistance in the acquisition of these materials.

Twenty-five of the bales have been received at the Atlanta warehouse. These include 10 b/c from Memphis; 10 b/c from Augusta and 5 b/c from the Dallas territory. The other five from Dallas and the ten from the Atlanta territory are to be in Atlanta soon as they are coming individually via truck motor freight. The lot from Bakersfield is ready for shipment but has been delayed by a new California regulation regarding length of trucks which has prevented the Carpet Company truck from entering the state. It is anticipated that this difficulty will be resolved soon, otherwise different arrangements will be made. The

California difficulty has precluded the Arizona shipment from being picked up but it is also ready and will be definitely arranged for soon. The Greenwood and Montgomery lots are due to arrive early in May. The Lubbock shipment is enroute via railroad and should be arriving also in early May.

Part II; Cotton Sampler Blender. Since the last letter report, work has continued on the literature survey. It is hoped that this portion of the study will be completed prior to July 1, 1968.

Respectfully submitted.

J. W. McCarty
Project Director, Part I

W. C. Boteler
Project Director, Part II

Approved:

James L. Taylor, Director
A. French Textile School

JWM/cp

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QUARTERLY REPORT NO. 1

PROJECT NO. B-1310

WITH-IN BALE VARIABILITY OF COTTON

Prepared for

Cotton Producer's Institute

by

J. W. McCarty

and

L. C. Young

I. INTRODUCTION

This report covers the work accomplished on the study of within bale variability of cotton during the past three months. The bulk of the work during the quarter was involved with the exhaustive study of a preliminary five bale lot of cotton. These five bales were obtained from the areas specified in the project proposal as follows:

Bale No. 1:	Augusta Territory	From Sandersville, Georgia
Bale No. 2:	Lubbock Territory	From Ralls, Texas
Bale No. 3:	Lubbock Territory	From O'Donnell, Texas
Bale No. 4:	Memphis Territory	From Marvell, Arkansas
Bale No. 5:	Dallas Territory	From Garland, Texas

II. TEST PROGRAM

Upon receipt at the laboratory, each of the five bales was laid on one of the covered sides and the metal ties removed. The bale was then allowed to "bloom" for twenty-four hours so that the size was approximately twice as much as the original flat bale size. After this initial "blooming" period, the entire bale was divided into sixteen layers of approximately the same thickness. This was accomplished by sticking small dividers into the edge of the bale at approximately the one-half; then one-fourth; then one-eighth; and, then one-sixteenth points.

Twenty-seven samples were then taken from each of the sixteen layers as diagramed in Figure One. Each sample taken was very carefully numbered so that the exact location of the position in the bale could be later determined as needed. The numbering system was standardized so that the first two digits indicated the bale number, the second two digits the layer number and the third two digits the sample number. For example: Sample No. 010527 indicated sample number twenty-seven from layer five taken from bale number one.

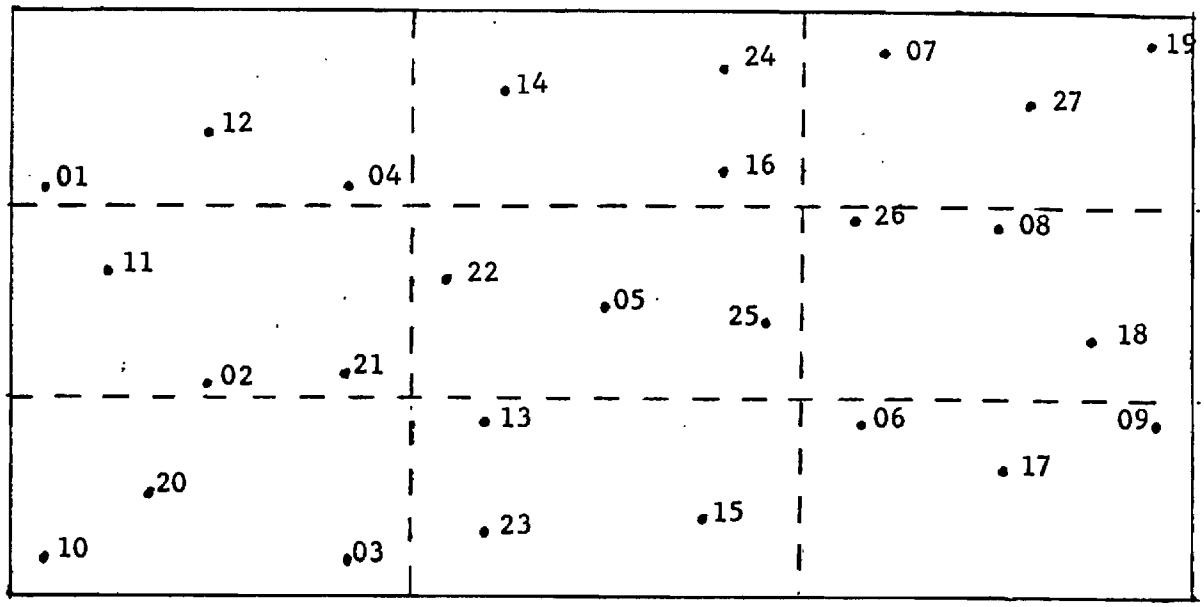

FIGURE I SAMPLE LOCATION WITHIN EACH LAYER

As taken, the samples were placed in trays which were then transported to the Fiber Evaluation Laboratory where they were placed in bins for conditioning in the uniform atmosphere for a period, usually overnight, until equilibrium was reached.

After conditioning, the samples were moved to the different test stations of the Fiber Evaluation Laboratory where Pressley strength, Fibrograph 50% and 2.5% Span Lengths, Fibronaire fineness, and Colorimeter reflectance and yellowness were determined. Each of the readings was recorded on the data card which accompanied the sample. These data cards were then removed from the sample and carried to the key punch station where these data were transferred to the punched card. The punched card was then ready to go to the computer for analysis and print-out.

III. TEST RESULTS

Table I gives a summary of the characteristics of the preliminary five bales of cotton as determined from the in-depth sampling studied.

TABLE I SUMMARY OF THE CHARACTERISTICS OF PRELIMINARY FIVE BALES

	Average Residual Variation σ_{res}	Overall Average Reading $\bar{X}$	* $100 \times \frac{\sigma_{res}/\sqrt{32}}{\bar{X}}$	Test Error σ_{test}	Ranges of Readings Within Bales Max. Range	Min. Range
Pressley	2.37	72.54	.58%	1.13	17.32	14.37
Micronaire	.061	3.36	.32%	.033	1.10	.35
50% Length, .01"	1.50	43.27	.61%	1.10	12.5	8.0
2.5% Length, .01"	1.81	99.42	.32%	1.14	15.0	10.0
Reflectance	.61	66.41	.16%	.47	15.2	6.2
Yellowness	.198	11.32	.31%	.19	2.1	1.6
Color Index	.86	86.50	.18%	.75	12.4	6.9
Uniformity	1.20	42.10	.50%	.97	10.	7.7

* This column gives the residual error component of a fan-head sample of thirty-two duplicated readings, expressed as a percentage of the typical bale average. It represents the best coefficient-of-variation of fan-head averages which might be obtained on the average, using 32 pairs of tests. It would be increased only slightly (10% to 30%) if the tests were not duplicate.

The third column contains perhaps the most pertinent data. Assuming that each of the thirty-two tufts of cotton to be tested in a fan-head sample was drawn completely and representatively from its one-thirty second of the layers of the bale, and that it is homogeneous when tested, then one should have 95% confidence that the difference between the bale mean and the fan-head sample mean will be no greater than 1.96 times the value shown for each quality in the third column. Since it is awkward to have to qualify such a statement in terms

of homogeneity and representation, a study is currently being made regarding a reduction of "between-layers-within-group-of-layers" variability as the number of groups is increased within the bale. In a limited number of bales a division into sixty-four layers has been made and the variability within thirty-two groups of two layers each has in general been no less than that within sixteen groups of four layers each. On occasion, however, it has dipped to just one-half of the latter, showing that stratification extends even to this level in some bales from some locations.

IV DISCUSSION OF RESULTS

Table II gives an analysis of the variance of the results of tests made on samples taken from within bales 1 through 5. In this analysis, the only source of variation which is consistently and significantly present is the between layer (L) variability. Among the six characteristics listed in this table, there was occasional evidence of significant variation due to other factors, but this was sporadic and suggests that the only non-random cause which can readily be shown to affect all bales is the change in quality from one layer to another. For example, in bale No. 1 there was significant variation between widths (W) in both 50% span length and in 2.5% span length and in bale No. 2 there was significant variation in Pressley strength between widths within depths (W and W x D); in Fibronaire between depths (D); and, in reflectance between positions within depths and widths (D and W and D x W).

Use of the Shirley Miniature Card for the preparation of composite samples appears to be inadequate in that it introduces bias and produces specimen which

TABLE II ANALYSIS OF VARIANCE OF PRELIMINARY FIVE BALES

Pressley Strength

Factor	Degrees of Freedom	Preliminary Bale Number One	Two	Three	Four	Five
D	2	6.89	4.95	3.44	14.54	1.77
W	2	3.86	17.15	.29	.69	8.70
L	15	21.89	10.79	14.94	14.02	15.37
D x W	4	5.54	14.41	2.58	4.68	9.13
W x L	30	6.06	4.91	6.42	3.61	4.10
L x D	30	3.70	5.23	3.35	5.15	4.82
L x D x W	60	3.37	7.36	4.92	5.30	5.94
Resid.	288	4.99	6.62	5.77	5.24	5.58

Micronaire

D	2	.0003	.0175	.0023	.0395	.0022
W	2	.0030	.0005	.0036	.0201	.0000
L	15	2.0447	.0209	.1333	.6090	.1043
D x W	4	.0025	.0015	.0027	.0056	.0011
W x L	30	.0035	.0026	.0028	.0091	.0051
L x D	30	.0037	.0018	.0038	.0048	.0040
L x D x W	60	.0024	.0021	.0025	.0089	.0045
Resid.	288	.0020	.0018	.0027	.0082	.0036

50% Length

D	2	4.03	3.56	2.28	16.43	.82
W	2	19.37	.30	2.60	6.40	.89
L	15	38.72	9.73	7.39	14.94	26.69
D x W	4	2.35	4.39	.78	6.17	1.97
W x L	30	2.89	2.10	1.58	2.71	1.98
L x D	30	1.57	2.55	2.57	2.10	1.24
L x D x W	60	3.09	1.77	1.712	1.51	1.45
Resid.	288	2.72	1.95	2.02	2.52	2.04

TABLE II ANALYSIS OF VARIANCE OF PRELIMINARY FIVE BALES (continued)

2.5% Length

Factor	Degrees of Freedom	Preliminary Bale Number One	Two	Three	Four	Five
D	2	4.21	7.07	1.51	6.23	.13
W	2	18.03	6.57	3.39	4.67	.59
L	15	50.40	12.39	46.82	16.10	13.20
D x W	4	.08	4.39	1.15	2.27	1.29
W x L	30	2.91	3.14	2.69	2.32	3.85
L x D	30	1.97	4.34	6.54	2.31	2.29
L x D x W	60	2.94	2.56	4.99	3.83	3.04
Resid.	288	2.28	2.94	4.38	2.90	3.86

R_d Reflectance

D	2	.21	2.04	.22	4.33	1.03
W	2	.31	.77	.36	.04	.60
L	15	32.97	5.32	24.55	25.94	17.27
D x W	4	.10	.86	.22	.14	.21
W x L	30	.26	.53	.27	.43	.93
L x D	30	.16	.30	.26	.30	.70
L x D x W	60	.19	.31	.23	.33	.58
Resid.	288	.18	.41	.26	.36	.66

+B Yellowness

D	2	.060	.121	.106	.094	.032
W	2	.151	.081	.394	.080	.056
L	15	2.168	.766	1.484	2.264	2.604
D x W	4	.018	.022	.014	.015	.087
W x L	30	.061	.036	.033	.058	.044
L x D	30	.048	.036	.030	.065	.028
L x D x W	60	.027	.026	.040	.039	.042
Resid.	288	.036	.021	.037	.062	.041

WHERE

L represents variability among layers of the bale
W represents variability among widths of the bale
D represents variability among depths of the bale
L x W represents interaction variability among layers and widths
W x D represents interaction variability among widths and depths
D x L represents interaction variability among depths and layers

combination of layer, depth and width.

are more variable then the fan-head average of multiple tests. Consequently it appears reasonable to conclude that a fan-head sample may safely be used to represent the contents of most bales, if it contains components sufficient in selection and number to (1) Represent the groups of layers from which each component (tuft or composite) is drawn, and (2) Reduce the fan-head mean error, to give adequately close confidence limits, by having enough laboratory tests on the components.

In conclusion, it appears that the original decision to sample the principal number of bales from thirty-two layers was well founded, as treatment of those data should amply demonstrate the best compromise among number-of-layers, blending of sub-samples and number of sub-samples to be tested in order to give the desired confidence in bale quality.

Respectfully submitted,

J. W. McCarty
Project Director

Approved:

James L. Taylor, Director
French Textile School

A. FRENCH TEXTILE SCHOOL
GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA

FINAL REPORT

PROJECT NO. B - 1310

WITH-IN BALE VARIABILITY OF COTTON

Prepared For

COTTON PRODUCER'S INSTITUTE

by

James W. McCarty
Louis C. Young
Winston C. Boteler

February 1, 1969

A. FRENCH TEXTILE SCHOOL
GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA

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PART I

A STUDY OF THE WITH-IN BALE VARIABILITY OF COTTON

INTRODUCTION

This project was initiated by the Cotton Producers Institute for the purpose of studying the within-bale variation of cotton fibers and to begin a study of blending of these fibers so that a more uniform product could be obtained.

The program was divided into two parts: Part I entitled A Study of the With-in Bale Variability of Cotton; and, Part II entitled Research on an Improved Cotton Sample Blender.

The Part I program was further divided into three phases: Phase I entitled A Preliminary Mass Sampling; Phase II entitled The Basic Program; and, Phase III entitled A Study of Previous Work.

For the Phase I portion of the program, five bales of cotton were obtained from different areas of the cotton belt as specified below:

Bale No. 1: Augusta Territory from Sandersville, Georgia

Bale No. 2: Lubbock Territory from Ralls, Texas

Bale No. 3: Lubbock Territory from O'Donnell, Texas

Bale No. 4: Memphis Territory from Marvell, Arkansas

Bale No. 5: Dallas Territory from Garland, Texas

For the Phase II portion of the program, nine different ten bale lots were obtained from across the cotton belt from the areas specified below:

Area No. 1: Bakersfield, California

Area No. 2: Phoenix, Arizona

Area No. 3: Lubbock, Texas

Area No. 4: Dallas, Texas

Area No. 5: Memphis, Tennessee

Area No. 6: Greenwood, Mississippi

Area No. 7: Montgomery, Alabama

Area No. 8: Atlanta, Georgia

Area No. 9: Augusta, Georgia

The location within the territories listed above from which the different individual bales were obtained and the known information regarding each bale is given in the Appendix.

For the Phase III portion of the program, the data cards generated by the Sasser study at Texas Technological College were obtained and further statistical analysis was undertaken on these data.

PHASE I - THE PRELIMINARY MASS SAMPLING

A. THE TEST PROGRAM

Upon receipt at the laboratory, each of the five bales included in this phase of the program was laid on one of the covered sides and the metal ties removed. The bale was then allowed to "bloom" for at least twenty-four hours so that the thickness was approximately double that of the original flat bale. After this period, the entire bale was then divided into sixteen layers of approximately the same thickness. This was accomplished by inserting small dividers into the edge of the bale at approximate points, eg: the one-half point; then the one-fourth points; then the one-eighth points; and, then the one-sixteenth points.

Twenty-seven samples were then taken from each of the sixteen layers obtained as described above. These samples were taken from approximately the same positions on each layer as diagramed in Figure One. Each sample taken was very carefully numbered so that the location of the position within the bale could be later determined as needed. The numbering system

was standardized so that the first two digits of the number indicated the bale number, the second two digits indicated the layer number and the third two digits indicated the sample number. For example: Sample No. 010527 would be used to identify sample number twenty-seven from layer number five taken from bale number one.

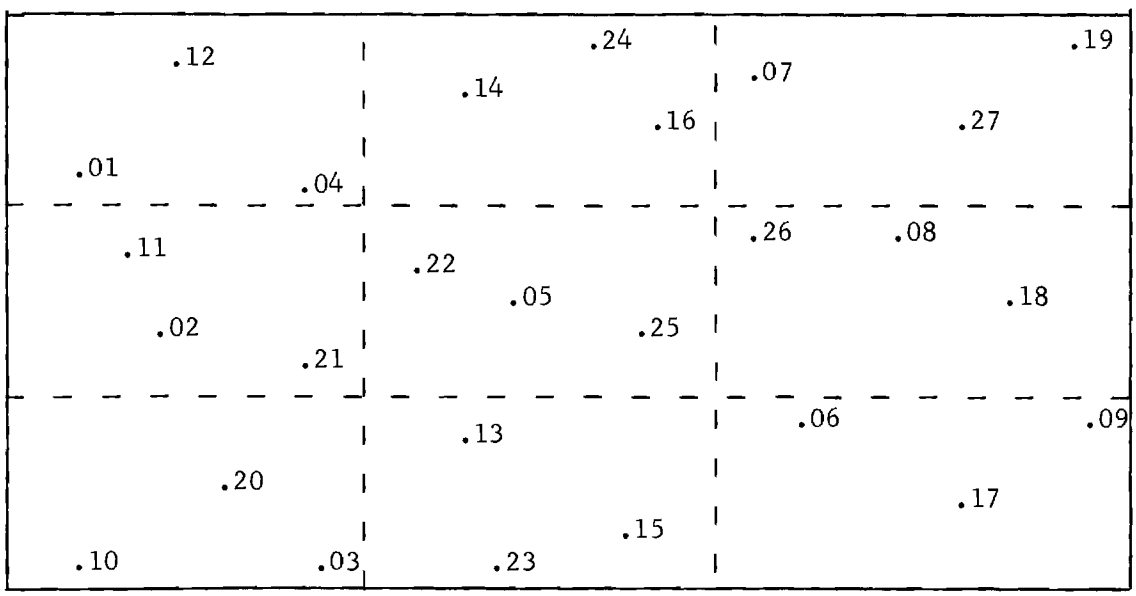

FIGURE ONE. SAMPLE LOCATION WITH-IN EACH LAYER

As taken, the samples were arranged in cardboard trays which were then transported to the Fiber Evaluation Laboratory where they were placed in bins for conditioning in the uniform atmosphere (65% relative humidity at 70° Fahrenheit) for a period, usually overnight, until equilibrium had been reached.

After conditioning, the samples were removed to the different test stations of the Fiber Evaluation Laboratory where Pressley strength, Fibrograph 50% and 2.5% span lengths, Fibronaire fineness, and Colorimeter reflectance and yellowness were determined. Each of the readings was recorded on the data card which accompanied the sample. These data cards were then removed from the samples and carried to the key punch station

where the data were transferred to the punched card. The punched card was then ready to go to the computer for analysis and print-out.

B. TEST RESULTS AND DISCUSSION

Tables Ia and Ib give a summary of the characteristics of the preliminary five bales of cotton as determined from the in-depth sampling study.

TABLE Ia AVERAGE CHARACTERISTICS OF THE PRELIMINARY FIVE BALES

ITEM OF TEST	Bale 1	Bale 2	Bale 3	Bale 4	Bale 5
Pressley Strength	79.53	67.86	68.22	76.78	83.27
Fibronaire Fineness	3.81	2.92	3.05	3.56	4.06
50% Span Length (.01")	46.5	44.2	41.4	49.9	41.2
2.5% Span Length (.01")	106.1	102.4	98.0	110.0	96.7
Reflectance (R_d)	76.5	69.6	64.8	60.0	73.0
Yellowness (+b)	9.4	12.0	13.0	12.8	11.0
Color Index	101.3	91.5	83.0	75.0	97.3
Uniformity Ratio	43.8	43.2	42.2	45.4	42.6

The third column in Table Ib contains perhaps the most pertinent data in that table. Assuming that each of the thirty-two tufts of cotton to be tested in a fan-head sample was drawn completely and representatively from its one-thirty-second of the layers of the bale, and that it

is homogeneous when tested, then one should have 95% confidence that the absolute difference between the bale mean and the fan-head sample mean will be no greater than 1.96 times the value shown in the third column for each quality. Since it is awkward to have to qualify such a statement in terms of homogeneity and representation, a study was made of the reduction in "between-layers-within-group-of-layers" variability

TABLE Ib SUMMARY OF THE CHARACTERISTICS OF PRELIMINARY FIVE BALES

ITEM OF TEST	Average Residual Variation * σ_{res}	Overall Average Reading $\bar{X}$	** $100 \times \frac{\sigma_{res}/\sqrt{32}}{\bar{X}}$	Test Error *** σ_{test}	Ranges of Readings Within Bales Max. Range	Min. Range
Pressley Strength	2.37	72.54	.58%	1.13	17.32	14.37
Fibronaire Fineness	.061	3.36	.32%	.033	1.10	.35
Length 50% Span(.01")	1.50	43.27	.61%	1.10	12.50	8.00
Length 2.5%Span(.01")	1.81	99.43	.32%	1.14	15.00	10.00
Uniformity Ratio	1.20	42.10	.50%	.97	10.00	7.70
Reflectance (R_d)	.61	66.42	.16%	.47	15.20	6.2
Yellowness(+b)	.198	11.32	.31%	.19	2.1	1.6
Color Index	.86	86.50	.18%	.75	12.40	6.90

* Of the means of two determinations from one tuft (Table II)

** This column gives the residual error component of a fan-head sample of thirty-two duplicated readings, expressed as a percentage of the typical bale average. It represents the coefficient-of-variation of fan-head averages which might be obtained on the average, using 32 pairs of determinations. It would be increased only slightly (10% to 30%) if the determinations were not duplicate.

*** Between determinations on the same tuft.

as the number of groups is increased within the bale. This was performed upon a few of the bales examined in Phase II. It indicated that

no significant increase in between layer variability was revealed in going from thirty-two layers to sixty-four layers.

Table II lists the results of blending composite samples from thirty-two layers and from four interlaced sets of eight layers, from each side of each of the five bales, for each of the eight quality characteristics. The last line in each listing represents the fan-head average of the thirty-two pairs of determinations made from tufts of the same samples which were blended.

Table III gives an analysis of the variance within bales of the results of tests made on samples taken from within bales 1 through 5. In this analysis, the only source of variation which is consistently and significantly present is the between-layer (L) variability.

Among the six characteristics listed in this table, there was occasional evidence of significant variation (at the 1% level) due to other factors, but this was sporadic and suggests that the only non-random cause which can readily be shown to affect all bales is the change in quality from one layer to another. The others were as follows:

Pressley:	Bale #2 between widths within depths (W + D x W)
Fineness:	Bale #2 between depths (D)
	Bale #4 between depths (D)
Length, 50%:	Bale #1 between widths (W)
	Bale #4 between positions in layers (D + W + D x W)
Length, 2.5%:	Bale #1 between widths (W)

TABLE II PHYSICAL CHARACTERISTICS OF BLENDED COMPOSITE SAMPLES

Item of TEST	BALE ONE		BALE TWO		BALE THREE		BALE FOUR		BALE FIVE	
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
Pressley Strength (MPSI)	82.74	78.50	65.96	64.35	65.46	65.65	75.02	73.70	85.11	82.82
	81.90	83.31	63.96	65.98	65.47	66.86	72.31	76 41	79.63	82.83
	80.94	79.32	65.04	66.29	63.69	67.51	73.28	77.73	81.87	79.94
	80.75	79.52	66.15	66.78	63.70	68.77	74.77	74.53	86.28	83.44
	82.46	79.65	66.27	65.62	66.35	65.27	75.35	73.53	81.93	84.33
	80.19	79.35	68.08	67.55	67.66	68.11	77.47	77.40	84.45	84.14
Fibro-naire Fineness (Mics)	3.80	3.80	3.00	3.05	3.18	3.25	3.50	3.48	4.15	4.28
	3.80	3.78	3.03	3.05	3.13	3.18	3.38	3.35	4.38	4.25
	3.80	3.90	3.08	3.03	3.10	3.13	3.58	3.45	4.25	4.35
	3.90	3.95	3.08	2.98	3.13	3.13	3.55	3.48	4.25	4.25
	3.73	3.78	3.03	3.05	3.18	3.25	3.55	3.55	4.25	4.22
	4.05	3.90	2.89	2.90	3.08	3.05	3.44	3.42	4.08	4.08
Fibro-graph 50% Span Length (in 0.1 ins)	44.50	50.00	47.50	46.50	45.00	44.00	43.50	39.50	39.50	40.50
	46.50	47.00	43.50	41.50	39.50	41.00	46.00	46.00	43.50	44.50
	50.00	47.00	44.00	45.00	40.00	43.00	47.50	48.00	44.00	41.50
	48.00	44.00	45.00	44.50	40.50	43.00	49.00	46.00	47.50	47.00
	48.50	46.50	42.00	44.50	41.50	44.50	50.00	48.00	43.00	46.00
	47.22	46.38	44.47	45.08	42.03	41.44	50.47	50.17	42.14	41.44
Fibro-graph 2.5% Span Length (in .01 ins)	105.00	105.50	103.00	103.00	101.00	99.50	107.00	104.00	95.50	94.00
	106.00	107.50	97.50	97.00	95.50	96.50	105.50	103.50	98.50	96.50
	106.00	107.00	101.50	98.00	95.50	96.50	106.50	105.50	95.00	95.00
	105.50	104.00	99.00	100.50	95.00	96.00	107.00	104.50	97.00	98.50
	106.50	107.00	99.50	101.00	96.50	98.50	108.50	107.00	94.00	97.00
	106.45	105.97	103.02	103.33	98.61	97.72	110.23	110.39	96.67	96.67
Color-imeter Reflectance (Rd)	76.50	78.15	70.25	69.40	64.65	65.65	60.25	61.70	74.45	75.75
	76.65	78.00	70.70	70.00	66.75	66.00	61.50	61.00	75.95	75.25
	77.50	77.65	70.00	70.80	66.50	66.25	61.50	61.90	75.50	75.25
	78.40	78.10	70.00	69.75	65.60	65.75	60.90	61.10	75.50	75.50
	77.25	78.75	71.35	70.75	66.20	67.25	60.00	61.25	75.75	75.15
	75.95	76.46	68.91	69.51	64.56	64.25	59.90	60.00	72.54	72.83
Color - imeter Yellowness (+b)	9.70	9.25	12.00	12.00	13.10	13.05	13.20	13.35	11.25	11.05
	9.20	8.90	11.90	11.90	12.90	12.90	12.90	13.10	11.00	10.90
	9.25	9.10	11.90	12.00	12.95	12.90	13.00	12.80	10.90	11.05
	9.15	9.15	11.90	12.00	13.00	12.90	13.20	13.05	10.95	10.90
	9.75	9.75	11.90	11.80	12.90	12.75	13.45	13.10	10.80	10.80
	9.08	9.21	12.26	12.02	13.19	13.23	13.08	12.93	10.94	10.95
Color - imeter Color Index	101.62	104.34	92.95	91.44	82.56	84.70	75.40	77.73	100.26	102.00
	101.41	103.34	93.24	92.95	87.14	85.58	77.53	76.45	102.52	100.71
	103.29	103.25	92.45	94.17	85.71	85.62	77.44	78.12	100.97	101.56
	104.01	103.64	92.65	92.62	84.86	84.81	76.63	76.47	101.03	100.97
	102.63	104.77	94.51	93.72	85.78	87.21	75.05	76.70	101.54	100.24
	100.20	100.99	90.42	91.48	82.46	81.95	75.00	75.08	96.39	96.73
Fibro-graph Uniformity Ratio (50%/2.5%)	42.38	47.38	46.12	45.10	44.51	44.20	41.12	41.83	41.37	43.08
	43.84	43.74	44.61	42.74	41.36	42.48	43.63	44.44	44.18	46.11
	47.17	43.93	43.35	46.03	41.91	44.56	44.60	45.48	46.32	43.68
	45.50	42.31	45.45	44.26	42.63	44.79	45.77	44.00	48.98	47.72
	45.54	43.45	42.23	44.11	43.00	45.15	46.08	44.86	45.75	47.42
	44.35	43.76	43.16	43.61	42.65	42.42	45.78	45.44	43.60	42.85

TABLE III ANALYSIS OF VARIANCE OF PRELIMINARY FIVE BALES

Pressley Strength

Factor	Degrees of Freedom	Preliminary Bale Number One	Two	Three	Four	Five
D	2	6.89	4.95	3.44	14.54	1.77
W	2	3.86	17.15	.29	.69	8.70
L	15	21.89	10.79	14.94	14.02	15.37
D x W	4	5.54	14.41	2.58	4.68	9.13
W x L	30	6.06	4.91	6.42	3.61	4.10
L x D	30	3.70	5.23	3.35	5.15	4.82
L x D x W	60	3.37	7.36	4.92	5.30	5.94
Resid.	288	4.99	6.62	5.77	5.24	5.58

Micronaire

D	2	.0003	.0175	.0023	.0395	.0022
W	2	.0030	.0005	.0036	.0201	.0000
L	15	2.0447	.0209	.1333	.6090	.1043
D x W	4	.0025	.0015	.0027	.0056	.0011
W x L	30	.0035	.0026	.0028	.0091	.0051
L x D	30	.0037	.0018	.0038	.0048	.0040
L x D x W	60	.0024	.0021	.0025	.0089	.0045
Resid.	288	.0020	.0018	.0027	.0082	.0036

50% Length

D	2	4.03	3.56	2.28	16.43	.82
W	2	19.37	.30	2.60	6.40	.89
L	15	38.72	9.73	7.39	14.94	26.69
D x W	4	2.35	4.39	.78	6.17	1.97
W x L	30	2.89	2.10	1.58	2.71	1.98
L x D	30	1.57	2.55	2.57	2.10	1.24
L x D x W	60	3.09	1.77	1.712	1.51	1.45
Resid.	288	2.72	1.98	2.02	2.52	2.04

(more)

TABLES III ANALYSIS OF VARIANCE OF PRELIMINARY FIVE BALES (continued)

2.5% Length

Factor	Degrees of Freedom	Preliminary Bale Number One	Two	Three	Four	Five
D	2	4.21	7.07	1.51	6.23	.13
W	2	18.03	6.57	3.39	4.67	.59
L	15	50.40	12.39	46.82	16.10	13.20
D x W	4	.08	4.39	1.15	2.27	1.29
W x L	30	2.91	3.14	2.69	2.32	3.85
L x D	30	1.97	4.34	6.54	2.31	2.29
L x D x W	60	2.94	2.56	4.99	3.83	3.04
Resid.	288	2.28	2.94	4.38	2.90	3.86
		Rd Reflectance				
D	2	.21	2.04	.22	4.33	1.03
W	2	.31	.77	.36	.04	.60
L	15	32.97	5.32	24.55	25.94	17.27
D x W	4	.10	.86	.22	.14	.21
W x L	30	.26	.53	.27	.43	.93
L x D	30	.16	.30	.26	.30	.70
L x D x W	60	.19	.31	.23	.33	.58
Resid.	288	.18	.41	.26	.36	.66
		+B Yellowness				
D	2	.060	.121	.106	.094	.032
W	2	.151	.081	.394	.080	.056
L	15	2.168	.766	1.484	2.264	2.604
D x W	4	.018	.022	.014	.015	.087
W x L	30	.061	.036	.033	.058	.044
L x D	30	.048	.036	.030	.065	.028
L x D x W	60	.027	.026	.040	.039	.042
Resid.	288	.036	.021	.037	.062	.041

WHERE

L represents variability among layers of the bale
W represents variability among widths of the bale
D represents variability among depths of the bale
L x W represents interaction variability among layers and widths
W x D represents interaction variability among widths and depths
D x L represents interaction variability among depths and layers
L x D x W represents interaction variability among layers , depths and widths
Residual represents variability among the three samples within each combination of layer, depth and width.

Uniformity Ratio:	Bale #1	between widths (W)
	Bale #2	between depths within layers (D + D x W)
	Bale #4	between positions in layers (D + W + D x W)
Reflectance (R_d):	Bale #2	between positions in layers (D + W + D x W)
	Bale #4	between depths (D)
Yellowness (+b):	Bale #3	between widths (W)
Color Index:	Bale #2	between positions in layers (D + W + D x W)
	Bale #4	between depths (D)

Table IV compares the thirty-two part composite sample averages with the corresponding bale average, expressing the signed difference as a percentage of the latter. A large number of like signs among each ten is taken to be evidence of bias; for example, the eight negative differences in Pressley strength suggest that the fibers may have been weakened in forming the composite in the miniature card.

Use of the Shirley miniature card for the preparation of composite samples appears to be inadequate in that it introduces bias and produces specimens which are more variable than the fan-head average of multiple tests. Consequently it appears reasonable to conclude that a fan-head sample may safely be used to represent the contents of most bales, if it contains components sufficient in selection and number to (1) represent the groups of layers from which each component (tuft or composite) is drawn, and (2) reduce the fan-head mean error, to give adequately close

confidence limits, by having enough laboratory tests on the components

TABLE IV COMPOSITE SAMPLES BLENDED FROM 32 LAYERS (DIFFERENCE BETWEEN COMPOSITE AND BALE AVERAGE EXPRESSED AS A PERCENTAGE OF BALE AVERAGE)

ITEM OF TEST	BALE #1	BALE #2	BALE #3	BALE #4	BALE #5	SIDE
Pressley	+4.03	-2.79	-4.04	-2.29	+2.20	Left
Strength	-1.30	-5.17	-3.76	-4.02	-0.55	Right
Fibronaire	-0.18	+2.65	+3.95	-1.82	+2.15	Left
Fineness	-0.18	+4.36	+6.41	-2.52	+5.22	Right
Length	-4.28	+7.40	+8.79	-11.84	-4.11	Left
50% Span	+7.55	+5.14	+6.37	-12.84	-1.70	Right
Length	-1.02	+0.57	+3.05	-2.74	-1.28	Left
2.5% Span	-0.54	+0.57	+1.52	-5.46	-2.83	Right
Uniformity	-3.28	+6.81	+5.43	-9.36	-2.87	Left
Ratio	+8.13	+4.44	+4.69	-7.79	+1.15	Right
Reflectance	+0.02	+1.00	-0.29	+0.47	+1.96	Left
(R_d)	+2.18	-0.22	+1.26	+2.89	+3.74	Right
Yellowness	+3.23	+0.24	+0.74	+2.91	+2.21	Left
(+b)	-1.56	+0.24	+0.36	+4.08	+0.39	Right
Color	+0.27	+1.58	-0.55	+0.47	+3.07	Left
Index	+2.95	-0.07	+2.04	+3.58	+4.85	Right

In conclusion, it appears from the results of Phase I that the original decision to sample the principal number of bales in Phase II from thirty-two layers was well founded as treatment of those data

should amply demonstrate the best compromise among number-of-layers, blending of sub-samples and number of sub-samples to be tested in order to give the desired confidence in bale quality.

PHASE II - THE BASIC PROGRAM

A. THE TEST PROGRAM

After completion of the preliminary mass sampling, the program continued with a study of ninety bales (nine different ten bale lots) acquired from territiries spread completely across the cotton belt. (These territories are detailed in the introduction). We are indebted to the United States Department of Agriculture, Consumer and Marketing Service, Cotton Classing Division for assistance in the selection and procurement of the needed types and varieties of cotton to be included in this program. The field representatives in these different territories very carefully ferreted out and obtained for shipment to our Atlanta Warehouse the requested bales based on the information contained in a request forwarded to Mr. S. C. Rademaker, Cotton Division Chief, Washington, D. C., under date of February 1, 1968. This letter is reproduced in the Appendix. Essentially, it requested the field men to look for ten bales which would generally fit the following description: Six bales from the first part of the harvest and four from the second part of the harvest; the bales to be randomly chosen without regard to grade or staple but each should come from distinctly different growing and/or handling areas within the field office territory and be thoroughly

representative of the cotton being grown in the territory.

After the field representative had selected and procured the entire ten bale lot, arrangements were made to have it accumulated at some suitable central location for pick-up if it was not already warehoused at one location. The different lots were then forwarded to the Gulf Atlantic Warehouse in Atlanta via the most economical method. These instructions went out in a second communication to Mr. Rademaker under date of February 26, 1968. This is also reproduced in the Appendix.

At the warehouse, a site was cleared near the press so that a minimum of handling of the partially opened bales was necessary in order to put them back together. Each bale was opened at one end by removing two of the metal ties. From the fanned head so formed thirty-two samples were taken, more or less evenly spaced from edge to edge. A portion of each sample was set aside to form a composite. These composite samples were then merged using a Shirley Miniature Card. This method of handling produced a very neppy and otherwise damaged sample so that the results of tests on these merged specimen were quite different from the individual sample readings. It was therefore concluded that these should not be included in the overall program report.

In the Fiber Evaluation Laboratory, the samples were tested in the same manner as for the five preliminary bales. As the determinations were made, the results were recorded on a data card which accompanied the samples as it was moved from station to station within the Laboratory.

The completed data card was then carried to the key-punch machine where the data was punched onto the card. The punched cards were then

transferred to the Burroughs B-5500 computer for analysis.

B. TEST RESULTS AND DISCUSSION

The results of the tests upon the bales included in Phase II are displayed in Table V. Each of the four sections of this table shows the relative reliability of a fan-head sample of tufts drawn from a specified number of layers throughout the bale. In each case, this has been done by tabulating the difference (in specified units of the quality measure) between a fan-head sample average and the average of all samples from the bale. The number of layers sampled ranged from thirty-two down to four, as indicated in the caption of each section.

In the first section, the average of thirty-two pairs of determinations is subtracted from the average for the bale (i. e., sixty-four such pairs) for the two such fan-head samples for each of ninety bales. The one-hundred and eighty such differences are tabulated in a frequency distribution in that section for each quality characteristic as shown. As may be seen in the frequency distribution relating to Pressley strength, only two out of one-hundred and eighty samples are further from the bale average than 100 psi. Similar observations may be drawn from the remainder of the table. It should be noted here, however, that the bale average is formed from a finite (and in this case limited number of two) number of fan-head samples. The effect of this is to make these distributions narrower or less variable than they would otherwise be. Accordingly, any confidence limits drawn directly from these tabulations should have the confidence deviate-limit multiplied by a factor $\frac{1}{\sqrt{1 - N/64}}$, where N is the number of sixty-four layers contained in the sub-sample. For example, in the case just considered,

TABLE V FREQUENCY DISTRIBUTIONS OF FAN HEAD SAMPLE AVERAGES

NO. OF SAMPLE AVERAGES DIFFERING FROM BALE AVERAGE BY STATED AMOUNT; SAMPLES FROM 32 LAYERS

PRESSLEY MPSI		FIBRONAIRE		50% LGTH, .01"		2.5% LGTH,.01"		REFLECTANCE RD		YELLOWNESS +B		COLOR INDEX		50%L/2.5%L, %	
FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.
BELOW-4.50	0	BELOW-0.09	0	BELOW-4.50	0	BELOW-4.50	0	BELOW-0.90	1	BELOW-0.45	0	BELOW-1.80	1	BELOW-1.80	0
-4.50-4.00	0	-0.09-0.08	0	-4.50-4.00	0	-4.50-4.00	0	-0.90-0.80	2	-0.45-0.40	0	-1.80-1.60	0	-1.80-1.60	0
-4.00-3.50	0	-0.08-0.07	0	-4.00-3.50	0	-4.00-3.50	0	-0.80-0.70	0	-0.40-0.35	0	-1.60-1.40	0	-1.60-1.40	0
-3.50-3.00	0	-0.07-0.06	0	-3.50-3.00	0	-3.50-3.00	0	-0.70-0.60	0	-0.35-0.30	2	-1.40-1.20	1	-1.40-1.20	0
-3.00-2.50	0	-0.06-0.05	0	-3.00-2.50	0	-3.00-2.50	0	-0.60-0.50	1	-0.30-0.25	1	-1.20-1.00	0	-1.20-1.00	1
-2.50-2.00	0	-0.05-0.04	0	-2.50-2.00	0	-2.50-2.00	0	-0.50-0.40	1	-0.25-0.20	0	-1.00-0.80	1	-1.00-0.80	0
-2.00-1.50	0	-0.04-0.03	0	-2.00-1.50	0	-2.00-1.50	0	-0.40-0.30	1	-0.20-0.15	2	-0.80-0.60	0	-0.80-0.60	0
-1.50-1.00	1	-0.03-0.02	6	-1.50-1.00	1	-1.50-1.00	0	-0.30-0.20	2	-0.15-0.10	2	-0.60-0.40	0	-0.60-0.40	3
-1.00-0.50	12	-0.02-0.01	21	-1.00-0.50	5	-1.00-0.50	5	-0.20-0.10	16	-0.10-0.05	10	-0.40-0.20	12	-0.40-0.20	18
-0.50 0.00	77	-0.01 0.00	62	-0.50 0.00	82	-0.50 0.00	84	-0.10 0.00	66	-0.05 0.00	73	-0.20 0.00	75	-0.20 0.00	68
0.00 0.50	77	0.00 0.01	64	0.00 0.50	86	0.00 0.50	85	0.00 0.10	67	0.00 0.05	73	0.00 0.20	75	0.00 0.20	68
0.50 1.00	12	0.01 0.02	21	0.50 1.00	5	0.50 1.00	6	0.10 0.20	15	0.05 0.10	10	0.20 0.40	12	0.20 0.40	18
1.00 1.50	1	0.02 0.03	6	1.00 1.50	0	1.00 1.50	0	0.20 0.30	2	0.10 0.15	2	0.40 0.60	0	0.40 0.60	3
1.50 2.00	0	0.03 0.04	0	1.50 2.00	1	1.50 2.00	0	0.30 0.40	1	0.15 0.20	2	0.60 0.80	0	0.60 0.80	0
2.00 2.50	0	0.04 0.05	0	2.00 2.50	0	2.00 2.50	0	0.40 0.50	1	0.20 0.25	0	0.80 1.00	1	0.80 1.00	0
2.50 3.00	0	0.05 0.06	0	2.50 3.00	0	2.50 3.00	0	0.50 0.60	1	0.25 0.30	1	1.00 1.20	0	1.00 1.20	1
3.00 3.50	0	0.06 0.07	0	3.00 3.50	0	3.00 3.50	0	0.60 0.70	0	0.30 0.35	2	1.20 1.40	1	1.20 1.40	0
3.50 4.00	0	0.07 0.08	0	3.50 4.00	0	3.50 4.00	0	0.70 0.80	0	0.35 0.40	0	1.40 1.60	0	1.40 1.60	0
4.00 4.50	0	0.08 0.09	0	4.00 4.50	0	4.00 4.50	0	0.80 0.90	2	0.40 0.45	0	1.60 1.80	0	1.60 1.80	0
4.50 & UP	0	0.09 & UP	0	4.50 & UP	0	4.50 & UP	0	0.90 & UP	1	0.45 & UP	0	1.80 & UP	1	1.80 & UP	0
TOTAL	180		180		180		180		180		180		180		180

NO. OF SAMPLE AVERAGES DIFFERING FROM BALE AVERAGE BY STATED AMOUNT; SAMPLES FROM 16 LAYERS

PRESSLEY MPSI		FIBRONAIRE		50% LGTH, .01"		2.5% LGTH,.01"		REFLECTANCE RD		YELLOWNESS +B		COLOR INDEX		50%L/2.5%L, %	
FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.
BELOW-4.50	0	BELOW-0.09	0	BELOW-4.50	0	BELOW-4.50	0	BELOW-0.90	2	BELOW-0.45	0	BELOW-1.80	3	BELOW-1.80	0
-4.50-4.00	0	-0.09-0.08	0	-4.50-4.00	0	-4.50-4.00	0	-0.90-0.80	3	-0.45-0.40	1	-1.80-1.60	0	-1.80-1.60	0
-4.00-3.50	0	-0.08-0.07	2	-4.00-3.50	0	-4.00-3.50	0	-0.80-0.70	1	-0.40-0.35	0	-1.60-1.40	0	-1.60-1.40	1
-3.50-3.00	0	-0.07-0.06	1	-3.50-3.00	0	-3.50-3.00	0	-0.70-0.60	1	-0.35-0.30	2	-1.40-1.20	1	-1.40-1.20	0
-3.00-2.50	0	-0.06-0.05	1	-3.00-2.50	0	-3.00-2.50	0	-0.60-0.50	3	-0.30-0.25	3	-1.20-1.00	2	-1.20-1.00	0
-2.50-2.00	1	-0.05-0.04	3	-2.50-2.00	1	-2.50-2.00	0	-0.50-0.40	2	-0.25-0.20	2	-1.00-0.80	3	-1.00-0.80	0
-2.00-1.50	2	-0.04-0.03	19	-2.00-1.50	0	-2.00-1.50	0	-0.40-0.30	10	-0.20-0.15	3	-0.80-0.60	9	-0.80-0.60	8
-1.50-1.00	13	-0.03-0.02	23	-1.50-1.00	1	-1.50-1.00	6	-0.30-0.20	22	-0.15-0.10	14	-0.60-0.40	11	-0.60-0.40	20
-1.00-0.50	43	-0.02-0.01	57	-1.00-0.50	25	-1.00-0.50	27	-0.20-0.10	60	-0.10-0.05	35	-0.40-0.20	48	-0.40-0.20	58
-0.50 0.00	126	-0.01 0.00	69	-0.50 0.00	163	-0.50 0.00	150	-0.10 0.00	73	-0.05 0.00	126	-0.20 0.00	112	-0.20 0.00	92
0.00 0.50	111	0.00 0.01	83	0.00 0.50	136	0.00 0.50	141	0.00 0.10	81	0.00 0.05	112	0.00 0.20	90	0.00 0.20	99
0.50 1.00	50	0.01 0.02	57	0.50 1.00	31	0.50 1.00	33	0.10 0.20	60	0.05 0.10	38	0.20 0.40	50	0.20 0.40	48
1.00 1.50	12	0.02 0.03	26	1.00 1.50	2	1.00 1.50	3	0.20 0.30	16	0.10 0.15	10	0.40 0.60	19	0.40 0.60	27
1.50 2.00	1	0.03 0.04	9	1.50 2.00	1	1.50 2.00	0	0.30 0.40	11	0.15 0.20	6	0.60 0.80	8	0.60 0.80	5
2.00 2.50	0	0.04 0.05	6	2.00 2.50	0	2.00 2.50	0	0.40 0.50	6	0.20 0.25	0	0.80 1.00	0	0.80 1.00	1
2.50 3.00	1	0.05 0.06	2	2.50 3.00	0	2.50 3.00	0	0.50 0.60	1	0.25 0.30	4	1.00 1.20	1	1.00 1.20	0
3.00 3.50	0	0.06 0.07	0	3.00 3.50	0	3.00 3.50	0	0.60 0.70	2	0.30 0.35	4	1.20 1.40	2	1.20 1.40	1
3.50 4.00	0	0.07 0.08	0	3.50 4.00	0	3.50 4.00	0	0.70 0.80	0	0.35 0.40	0	1.40 1.60	0	1.40 1.60	0
4.00 4.50	0	0.08 0.09	1	4.00 4.50	0	4.00 4.50	0	0.80 0.90	1	0.40 0.45	0	1.60 1.80	0	1.60 1.80	0
4.50 & UP	0	0.09 & UP	1	4.50 & UP	0	4.50 & UP	0	0.90 & UP	5	0.45 & UP	0	1.80 & UP	1	1.80 & UP	0
TOTAL	360		360		360		360		360		360		360		360

TABLE V (CON'T) FREQUENCY DISTRIBUTIONS OF FAN HEAD SAMPLE AVERAGES

NO. OF SAMPLE AVERAGES DIFFERING FROM BALE AVERAGE BY STATED AMOUNT; SAMPLES FROM 8 LAYERS

PRESSLEY MPSI FIBRONAIRE 50% LGTH, .01" 2.5% LGTH, .01" REFLECTANCE RD YELLOWNESS +B COLOR INDEX 50%L/2.5%L, %

FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.
BELOW-4.50	1	BELOW-0.09	8	BELOW-4.50	0	BELOW-4.50	0	BELOW-0.90	7	BELOW-0.45	1	BELOW-1.80	7	BELOW-1.80	0
-4.50-4.00	0	-0.09-0.08	3	-4.50-4.00	0	-4.50-4.00	0	-0.90-0.80	8	-0.45-0.40	1	-1.80-1.60	0	-1.80-1.60	1
-4.00-3.50	0	-0.08-0.07	4	-4.00-3.50	0	-4.00-3.50	0	-0.80-0.70	7	-0.40-0.35	2	-1.60-1.40	2	-1.60-1.40	0
-3.50-3.00	0	-0.07-0.06	6	-3.50-3.00	0	-3.50-3.00	0	-0.70-0.60	4	-0.35-0.30	6	-1.40-1.20	3	-1.40-1.20	4
-3.00-2.50	6	-0.06-0.05	19	-3.00-2.50	0	-3.00-2.50	0	-0.60-0.50	6	-0.30-0.25	4	-1.20-1.00	12	-1.20-1.00	5
-2.50-2.00	11	-0.05-0.04	27	-2.50-2.00	2	-2.50-2.00	2	-0.50-0.40	18	-0.25-0.20	5	-1.00-0.80	11	-1.00-0.80	11
-2.00-1.50	14	-0.04-0.03	41	-2.00-1.50	6	-2.00-1.50	5	-0.40-0.30	37	-0.20-0.15	30	-0.80-0.60	29	-0.80-0.60	31
-1.50-1.00	46	-0.03-0.02	51	-1.50-1.00	18	-1.50-1.00	31	-0.30-0.20	68	-0.15-0.10	47	-0.60-0.40	53	-0.60-0.40	86
-1.00-0.50	112	-0.02-0.01	107	-1.00-0.50	115	-1.00-0.50	113	-0.20-0.10	80	-0.10-0.05	95	-0.40-0.20	101	-0.40-0.20	105
-0.50 0.00	169	-0.01 0.00	87	-0.50 0.00	196	-0.50 0.00	207	-0.10 0.00	118	-0.05 0.00	176	-0.20 0.00	148	-0.20 0.00	122
0.00 0.50	155	0.00 0.01	106	0.00 0.50	250	0.00 0.50	211	0.00 0.10	114	0.00 0.05	153	0.00 0.20	150	0.00 0.20	113
0.50 1.00	116	0.01 0.02	85	0.50 1.00	101	0.50 1.00	114	0.10 0.20	99	0.05 0.10	108	0.20 0.40	117	0.20 0.40	106
1.00 1.50	61	0.02 0.03	70	1.00 1.50	27	1.00 1.50	30	0.20 0.30	62	0.10 0.15	49	0.40 0.60	40	0.40 0.60	75
1.50 2.00	17	0.03 0.04	48	1.50 2.00	4	1.50 2.00	6	0.30 0.40	29	0.15 0.20	20	0.60 0.80	31	0.60 0.80	36
2.00 2.50	8	0.04 0.05	24	2.00 2.50	1	2.00 2.50	1	0.40 0.50	25	0.20 0.25	8	0.80 1.00	13	0.80 1.00	18
2.50 3.00	0	0.05 0.06	17	2.50 3.00	0	2.50 3.00	0	0.50 0.60	17	0.25 0.30	6	1.00 1.20	6	1.00 1.20	5
3.00 3.50	1	0.06 0.07	8	3.00 3.50	0	3.00 3.50	0	0.60 0.70	5	0.30 0.35	2	1.20 1.40	1	1.20 1.40	1
3.50 4.00	2	0.07 0.08	1	3.50 4.00	0	3.50 4.00	0	0.70 0.80	2	0.35 0.40	3	1.40 1.60	4	1.40 1.60	0
4.00 4.50	0	0.08 0.09	2	4.00 4.50	0	4.00 4.50	0	0.80 0.90	3	0.40 0.45	2	1.60 1.80	1	1.60 1.80	1
4.50 & UP	1	0.09 & UP	6	4.50 & UP	0	4.50 & UP	0	0.90 & UP	11	0.45 & UP	2	1.80 & UP	1	1.80 & UP	0
TOTAL	720		720		720		720		720		720		720		720

NO. OF SAMPLE AVERAGES DIFFERING FROM BALE AVERAGE BY STATED AMOUNT; SAMPLES FROM 4 LAYERS

PRESSLEY MPSI FIBRONAIRE 50% LGTH, .01" 2.5% LGTH, .01" REFLECTANCE RD YELLOWNESS +B COLOR INDEX 50%L/2.5%L, %

FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.	FROM TO	NO.
BELOW-4.50	6	BELOW-0.09	56	BELOW-4.50	0	BELOW-4.50	0	BELOW-0.90	42	BELOW-0.45	7	BELOW-1.80	24	BELOW-1.80	6
-4.50-4.00	9	-0.09-0.08	22	-4.50-4.00	0	-4.50-4.00	1	-0.90-0.80	16	-0.45-0.40	3	-1.80-1.60	6	-1.80-1.60	6
-4.00-3.50	3	-0.08-0.07	21	-4.00-3.50	0	-4.00-3.50	0	-0.80-0.70	31	-0.40-0.35	4	-1.60-1.40	17	-1.60-1.40	7
-3.50-3.00	10	-0.07-0.06	42	-3.50-3.00	2	-3.50-3.00	1	-0.70-0.60	27	-0.35-0.30	20	-1.40-1.20	33	-1.40-1.20	20
-3.00-2.50	21	-0.06-0.05	50	-3.00-2.50	2	-3.00-2.50	7	-0.60-0.50	50	-0.30-0.25	29	-1.20-1.00	40	-1.20-1.00	27
-2.50-2.00	40	-0.05-0.04	44	-2.50-2.00	13	-2.50-2.00	15	-0.50-0.40	58	-0.25-0.20	48	-1.00-0.80	52	-1.00-0.80	64
-2.00-1.50	78	-0.04-0.03	95	-2.00-1.50	33	-2.00-1.50	45	-0.40-0.30	83	-0.20-0.15	73	-0.80-0.60	78	-0.80-0.60	101
-1.50-1.00	134	-0.03-0.02	116	-1.50-1.00	98	-1.50-1.00	117	-0.30-0.20	98	-0.15-0.10	119	-0.60-0.40	111	-0.60-0.40	152
-1.00-0.50	182	-0.02-0.01	144	-1.00-0.50	232	-1.00-0.50	211	-0.20-0.10	134	-0.10-0.05	190	-0.40-0.20	134	-0.40-0.20	177
-0.50 0.00	239	-0.01 0.00	121	-0.50 0.00	340	-0.50 0.00	317	-0.10 0.00	135	-0.05 0.00	228	-0.20 0.00	196	-0.20 0.00	179
0.00 0.50	211	0.00 0.01	129	0.00 0.50	330	0.00 0.50	304	0.00 0.10	157	0.00 0.05	260	0.00 0.20	197	0.00 0.20	169
0.50 1.00	200	0.01 0.02	134	0.50 1.00	235	0.50 1.00	229	0.10 0.20	140	0.05 0.10	157	0.20 0.40	185	0.20 0.40	148
1.00 1.50	139	0.02 0.03	130	1.00 1.50	106	1.00 1.50	144	0.20 0.30	142	0.10 0.15	106	0.40 0.60	142	0.40 0.60	140
1.50 2.00	79	0.03 0.04	86	1.50 2.00	35	1.50 2.00	32	0.30 0.40	93	0.15 0.20	77	0.60 0.80	86	0.60 0.80	102
2.00 2.50	41	0.04 0.05	70	2.00 2.50	12	2.00 2.50	15	0.40 0.50	64	0.20 0.25	54	0.80 1.00	56	0.80 1.00	64
2.50 3.00	27	0.05 0.06	56	2.50 3.00	2	2.50 3.00	2	0.50 0.60	53	0.25 0.30	27	1.00 1.20	39	1.00 1.20	39
3.00 3.50	9	0.06 0.07	34	3.00 3.50	0	3.00 3.50	0	0.60 0.70	23	0.30 0.35	12	1.20 1.40	18	1.20 1.40	17
3.50 4.00	3	0.07 0.08	28	3.50 4.00	0	3.50 4.00	0	0.70 0.80	29	0.35 0.40	8	1.40 1.60	12	1.40 1.60	12
4.00 4.50	4	0.08 0.09	17	4.00 4.50	0	4.00 4.50	0	0.80 0.90	15	0.40 0.45	10	1.60 1.80	9	1.60 1.80	6
4.50 & UP	5	0.09 & UP	45	4.50 & UP	0	4.50 & UP	0	0.90 & UP	30	0.45 & UP	8	1.80 & UP	5	1.80 & UP	4
TOTAL	1440		1440		1440		1440		1440		1440		1440		1440

two out of one-hundred and eighty of the thirty-two tuft fan-head samples would then be expected to be outside of a range $\pm \frac{1,000}{\sqrt{1 - 32/64}}$ psi or 1414 psi from the true bale average. The effect of this correction is obviously of less magnitude for smaller samples.

It may be readily seen, in viewing the other sections of Table V, that representatively drawn samples from fewer layers tend to be more variable in their deviation from the bale mean. It should be borne in mind that these sub-sample averages are based on duplicate determinations of the stated number of tufts from as many layers. If only a single determination were made on each tuft, the dispersion would be increased by an amount of 10% to 30% as stated in the footnote to Table Ib.

A summary of the characteristics of the ninety bales examined in Phase II is given in Table VI.

TABLE VI SUMMARY OF CHARACTERISTICS OF NINETY BALES

ITEM OF TEST	σ_{test}*	Mean(early)	Mean (late)
Pressley Strength	1.83	80.90	79.59
Fibronaire Fineness	.05	4.25	3.81
50% Span Length (.01")	1.40	46.8	46.9
2.5% Span Length (.01")	1.54	105.0	106.2
Reflectance (R_d)	.81	75.1	73.0
Yellowness (+b)	.28	9.4	8.8
Color Index	1.21	98.8	94.7
Uniformity Ratio	1.16	44.5	44.2

*Of individual determinations about the mean of the pair on the same cotton sample. Based on 5760 degrees of freedom.

For the pair of classer's samples taken from each of the eighty bales available, two standard deviations were computed for each of the quality characteristics. (The ten bales for the Atlanta Territory were loaned to the project and were returned to the owner before it was decided to study regular classer's samples.) Both are listed in Table VII.

The first of the two (S_1 in Table VII) is the standard error between the mean of each sample (two tufts with two determinations on each tuft) and the mean of the pair of classer's samples (taken from opposite faces of the bale). The second (S_2) of the two is the standard error of the differance between the mean of both sides of the classer's sample (eight determinations) and the mean of the multi-layer samples (one hundred twenty-eight determinations) of the bale. Both sets of standard deviations are based on eighty degrees of freedom.

TABLE VII STANDARD ERROR OF CLASSER'S SAMPLE CHARACTERISTICS

ITEM OF TEST	S_1	S_2
Pressley Strength	1.87	3.39
Fibronaire Fineness	0.13	0.20
50% Span Length (.01")	1.78	2.67
2.5% Span Length (.01")	1.47	2.46
Reflectance (R_d)	0.91	2.26
Yellowness (+b)	0.18	0.51
Color Index	1.40	3.64
Uniformity Ratio	1.32	1.95

If there were no variation with-in the bales, the first column should be $\sqrt{2}$ as great as the second column, i. e. 40% larger, and it should be only one half as great as the test errors shown in the fourth column of Table Ib. The fact that the second column is so much greater than the

first indicates that there is a lot more difference between the average of the bale and the average of the classer's sample than there is between the two halves of the classer's sample. That is, they represent the bale more poorly than they do each other. The actual standard deviation in the second column may be viewed as the amount, in units shown for the measurement, by which the bale average will differ from the average of the two halves of the classer's sample about 32% of the time. (This assumes that four determinations will be made on each classer's sample).

PHASE III A STUDY OF PREVIOUS WORK

The study by Preston Sasser of one hundred-twenty bales of cotton has been reviewed to determine the standard deviations of each replicated determination on a given sample. Inasmuch as the 2.5% Span Length and the Fineness were the only quality measurements replicated among those contained on the IBM cards furnished the project, these were the only characteristics on which this computation was possible. The results were

$S = .0107''$ for Span Length and $S = .085$ for Fineness

with twelve hundred degrees of freedom. The first is comparable to that reported in Table I; the second is high, partly because the measurements were reported to only two digits.

On the study of fifty bales, with twenty sets of similar readings on each bale, the within-bale variability was computed. The standard deviations (based on 950 degrees of freedom) and the bale means are shown in Table VIII.

TABLE VIII STANDARD DEVIATION AND BALE MEANS FOR SASSER FIFTY BALE STUDY

ITEM OF TEST	Standard Deviation	Means of Bales
Pressley Strength (MPSI)	2.89	75.7
Upper Half Mean (ins)	.032	.959
Mean Length (ins)	.017	.431
Uniformity Ratio (%)	1.3	45.1
Fineness	.22	3.70
Reflectance (R_d)	1.08	72.8
Yellowness (+b)	.28	9.25

PART II

RESEARCH ON IMPROVED COTTON BLENDER

INTRODUCTION

A survey of literature references on fiber blending and a comparison of three laboratory blending systems were completed during this portion of Part II of the program. More than 200 references were examined during the course of the literature search. However, many of the articles were concerned with the techniques of blending at the roving stage or somewhere else in the mill. The 20 references listed in the bibliography are those which appear to have the most relevance to the task of developing a sample fiber blending system.

The three blending systems examined in the comparison study were the Custom Scientific Instruments table top blender, the Stanford Research Institute table top blender and the Shirley Institute miniature card.

PHASE I EVALUATION OF BLENDERS PRESENTLY AVAILABLE

A. THE TEST PROGRAM

Three different blending instruments were evaluated by three different methods as a part of the effort to develop a high speed cotton sample blending machine capable of rapid and effective blending with little or no damage to the fibers. The instruments evaluated were the Custom Scientific Instruments (C.S.I.) blender; the Stanford Research Institute (S.R.I.) blender; and, the Shirley Miniature Card.

The methods used for evaluation were (1) Dyeing cotton samples before blending, then examining the blend for coloration mixtures. (Digital fibrograph and Pressley strength measurements were made before and after blending.); (2) Dyeing cotton samples after blending.

Samples of mature and immature fibers were blended and then dyed. Color mixture was then examined to determine blending effectiveness; and, (3) Fibronaire mixtures. A sample with a high fibronaire reading was blended with a sample of low fibronaire reading. The fibronaire reading was blending with a sample of low fibronaire reading. The fibronaire test was performed on the blended sample and the results were compared with those for the unblended samples.

B. TEST RESULTS AND DISCUSSION

The C.S.I. blender used an adjustable feed plate in combination with a fluted feed roll which feeds the sample into a rotary blending cylinder which is covered with wire clothing. The blender is slow - approximately ten minutes is required to blend a four gram sample.

The S.R.I. blender is a vacuum type blender. A cotton sample is fed into the instrument through serrated rollers. As the fibers come through the feed rollers, they are picked up by a brush. Air is used to doff the fibers from the brush and to transport them through a tube to a condenser. After the sample has been fed into the instrument, the condenser is activated and the fibers are collected and doffed from the condenser by two serrated rollers. The sample is run through the instrument twice. Because the blending is accomplished by mixing the tufts in the air stream, the instrument blends much faster than the C.S.I. instrument.

The Shirley miniature card blender consists of a fluted feed roller, carding cylinder, doffing cylinder, and doffing comb. Many fibers are retained on the carding and doffing cylinders. The blend is produced as additional fibers are deposited during each revolution

of the cylinders. Superior blending is achieved with this instrument, however the method is very slow and many of the fibers are broken and damaged.

The first test method used cotton samples which had been dyed before blending. Direct dyeing procedures were used to prepare red and green samples. Exactly four grams of each sample were blended. The second method used mature and immature fibers which were blended together and then differentially dyed. Two grams each of the mature and immature fibers were blended together and then dyed using ASTM Method D1464-63 standards for differential dyeing. For the third method, two grams each of a 6.10 mic cotton and a 2.65 mic cotton were blended. The blend was then tested to obtain the blended Fibronaire fineness reading.

A visual examination of the blended samples obtained by the first method indicated that the distribution of red and green fibers was very uneven in each of the three blending instruments. In the case of the C.S.I. blender, the licker-in did not remove the fibers in tufts which were small enough to produce an even distribution. The S.R.I. blender produced a slightly better homogeneity than the C.S.I. blender but was still lacking in acceptability. The Shirley miniature card showed fairly good distribution of red and green fibers throughout, considerably better than that obtained on either the C.S.I. or the S.R.I. blenders. Table IX gives the results of characteristic studies made on these blended samples.

TABLE IX RESULTS OF METHOD ONE BLENDING

ITEM OF TEST	C.S.I. Blender		S.R.I. Blender		Shirley Card	
	Before Blending	After Blending	Before Blending	After Blending	Before Blending	After Blending
50% Span Length	49	49	49	49	49	49
2.5% Span Length	109	112	109	107	109	105
Uniformity Ratio	.45	.44	.45	.46	.45	.46
Pressley Strength (MPSI)	93.4	90.9	93.4	89.9	93.4	91.0

In the method two technique, the C.S.I. blender showed tufts of both red and green fibers indicating a very poor blending of the mature (red) fibers and the immature (green) material. The S.R.I. blender appeared to give a more uniform distribution throughout the sample but was still not at an acceptable level of blending. The Shirley card showed much better distribution throughout the sample than either of the other two blenders.

The fineness readings using the third method showed a reading on the blends of 4.00 mics for the C.S.I. blender, 3.98 mics for the S.R.I. blender and 3.95 mics for the Shirley card blend. These figures compare to the 4.37 arithmetic average obtained by mixing 6.10 and 2.65 together.

Both the physical blending and the physical test results were studied in evaluating the blending results. The miniature card did the best job of blending, however the fibers were extensively damaged. The S.R.I. blender did a fairly good job of blending the fibers and did not do extensive damage to the fibers but seemed to be entirely

too slow for wide spread use for the purpose under study. The C.S.I. blender did a poor job of blending as compared to the other two blenders studied.

RECOMMENDATIONS FOR FUTURE WORK

It is recommended that future development work on sample blenders be directed towards a suction-type device coupled with an improved licker-in system. For the preparation of larger samples, the use of a traveling type plucker, such as that used on the SRRL Continuous Bale Plucker, should be investigated. The use of a rapid plucker capable of removing very small tufts at a very high rate of speed, coupled with a multi-tube fluid delay line system, would permit the techniques demonstrated in the S.R.I. blender to be used in a production prototype. The full size bale-plucker operates at 1200 pounds-per-hour so that even a much smaller device would provide samples at a very high rate. The use of suction permits transport of the fibers with a minimum of tangling and damage and the use of delay lines would allow the fibers to be mixed as they reached the final sample receiver.

APPENDIX

GEORGIA INSTITUTE OF TECHNOLOGY
A. FRENCH TEXTILE SCHOOL
ATLANTA, GEORGIA 30332

February 1, 1968

Mr. S. C. Rademaker
Cotton Division - C&MS
United States Department of Agriculture
Washington, D. C. 20250

Dear Mr. Rademaker:

We have enjoyed very much our association with different elements of the Cotton Division C&MS and are particularily appreciative of the excellect cooperation we have received from your office as well as from Mr. Stancil and Mr. Deviney of the Atlanta district and Mr. Rouse of the Memphis Testing Section.

We have been working with Cotton Producers Institute developing a suggested research project in which we would undertake an exhaustive study of the with-in bale variability of cotton. Their suggested procedure is as follows:

(1) 5 bales of late harvest cotton (1 each from Augusts, Dallas, Memphis, and 2 from Lubbock) be acquired and studies exhaustively (300 to 500 samples each).

(2) Using information developed in the preliminary mass samplings, a less intensive sampling will be made from 90 additional bales. These 90 bales will be composed of 10 bales each from 9 acreas of the cotton belt as follows:

1. Bakersfield, California
2. Phoenix, Arizona
3. Lubbock, Texas
4. Dallas, Texas
5. Memphis, Tennessee
6. Greenwood, Mississippi
7. Montgomery, Alabama
8. Atlanta, Georgia
9. Auguata, Georgia

With representation between cotton from the first part of the season and cotton from the second part of the season and selection from different growing and ginning territories in each area among each group of 10 bales it is believed that within the total group there will be represented all but the most extreme condition of cotton quality.

The reason for this letter is to request the help of your division in the location, selection, and acquistion of the needed bales of cotton. If this program is approved, we would appreciate your arranging for representatives in the aboved named areas to select 10 bales from the current

crop (roughly 6 bales from the first part if the harvest and 4 from the second part of the harvest) and requesting their shipment to Atlanta along with an invoice to the Georgia Institute of Technology to cover the cost of same. Shipping instructions would be supplied as soon as the project is authorized.

It is proposed that bales would be randomly chosen without regards to grade or staple but should each come from distinctly different growing and/or handling areas within the field office territory.

Since the recent harvest was so short and the movement to market so rapid, we are most anxious to get this program underway as quickly as possible. If you feel your division can work with us in this way or if you have other suggestions, we would appreciate hearing from you at an early date.

Sincerly yours,

J. W. McCarty, PE
Associate Professor

JWM/lb

GEORGIA INSTITUTE OF TECHNOLOGY
A. FRENCH TEXTILE SCHOOL
ATLANTA, GEORGIA 30332

February 26, 1968

Mr. S. A. Rademaker
Cotton Division - C&MS
U. S. Department of Agriculture
Washington, D. C. 20250

Dear Mr. Rademaker:

Your recent letter agreeing to aid us in the selection and procurement of cotton needed for a CPI research study was most appreciated. The continued cooperation of your division has added considerably to our ability to aid, in our small way, the cotton industry of Georgia and the country.

We now have all the approvals needed to begin this study and would appreciate your notifying the various fields officers of our needs and desires. In this connection, our first instruction to these personnel should be that we are anxious that the ten bales which they are to secure from their territory would be as widely representative of the production of that area as it is possible to obtain without undue times and effort on their past to ferret out material which may not be readily available. We hope to obtain approximately six bales from the first part of the recent 1967 harvest and four bales from the second part of the harvest. Again, let me emphasize that this is not hard and fast and your men will certainly not be wxpected to spend any undue time searching for just exactly this combination. In addition, we hope that the ten bale lot will be as widely representative of the area as possible as regards ginning techniques, and/or conditions as well as grade and staple and variety of cotton. In this connection, any history or background which your men may be able to provide such as variety, time of growth, time of ginning, conditions of ginning, etc. will add materially to the overall study. Again, however, let me stress to you that this type of information is not a necessity to the program and will be welcomed if available.

Once the field representative has selected and procured the entire ten bale lot it would be most helpful if he could arrange to have it accumulated at some suitable central location for pick-up if it is not already warehoused at one location. We have made arrangements with a large carpet manufactures located here in Georgia to pick up the various lots and deliver them to the warehouse here in Atlanta. Once the lot is ready for shipment, if your men would call the writer (person per person COLLECT) at the following number: Area 404 873-4211, extension 360 I will notify the carpet company and relay instructions as to location. They will then pick up the lot the next time one of their trucks is in this area and bring it to Atlanta. If you see any objections to this procedure, I would be glad to discuss this with you.

All the bale should be shipped to the following address:
Georgia Institute of Technology
% Gulf Atlantic Warehouse
659 Auburn Avenue, N. E.
Atlanta, Georgia

All invoices should be forwarded to:
Georgia Institute of Technology
A. French Textile School
Fiber Evaluation Laboratory
Atlanta, Georgia 30332

In line with your suggestion, CPI has agreed that the California area should be represented in this study (They had specifically suggested its commission originallybecause of a previous study which they had made in which only California and Lubbick cotton had been similarly studied). We have now replaced the Harlingen area with the California area so that the nine areas to be studied are:

1. Bakersfield	2. Phoenix	3. Lubbock
4. Dallas	5. Memphis	6. Greenwood
7. Montgomery	8. Atlanta	9. Augusta

We will undertake to locate the five bales desired immediately for the preliminary mass sampling so would appreciate your men locating ten (10) bales in each of the nine areas listed above and causing them to be forwarded as detailed above. Again, let me agree with your observation that the timing is important and hope that your field men will be able to get these shipments off for Atlanta at an early date. Incidently, if they have any questions which you would want them to direct to me they may reach me at the following telephone: Area (404) 873-4211 extension 360 or 363. I would be more than glad to give them any additional information they might desire in this connection.

Again let me express our sincere thanks to you and your division for the continued cooperation in our efforts to improve our cotton.

Yours very truly,

J. W. McCarty, PE
Project Director
Fiber Evaluation Laboratory

JWM/lb

TABLE X EXAMPLES OF RESULTS ON BALE ONE IN PHASE ONE

MEANS AND VARIATIONS WITHIN BALE NO. 1, MICRONAIRE

AVERAGES OF CLUSTERS OF THREE SAMPLES

LAYER	L F	L C	L B	C F	C C	C B	R F	R C	R B
1	4.375	4.342	4.308	4.383	4.333	4.283	4.325	4.350	4.292
2	4.167	4.208	4.217	4.183	4.217	4.217	4.217	4.183	4.200
3	4.092	4.067	4.075	4.142	4.108	4.067	4.033	4.058	4.075
4	4.008	4.017	3.983	3.992	3.983	3.967	4.017	3.992	4.025
5	3.675	3.650	3.633	3.658	3.675	3.725	3.683	3.675	3.625
6	3.583	3.592	3.592	3.633	3.583	3.575	3.592	3.625	3.592
7	3.625	3.592	3.642	3.608	3.650	3.600	3.608	3.650	3.625
8	3.975	3.975	3.867	3.967	3.925	3.917	3.850	3.833	3.875
9	4.117	4.100	4.108	4.083	4.130	4.150	4.033	4.150	4.133
10	3.900	3.983	3.967	3.867	3.983	3.975	3.933	3.992	3.967
11	3.508	3.542	3.492	3.500	3.550	3.517	3.550	3.500	3.525
12	3.517	3.525	3.508	3.542	3.508	3.517	3.500	3.500	3.517
13	3.478	3.422	3.530	3.475	3.487	3.453	3.450	3.433	3.467
14	3.633	3.567	3.600	3.583	3.558	3.558	3.600	3.592	3.600
15	3.767	3.717	3.750	3.708	3.700	3.708	3.733	3.733	3.758
16	3.625	3.667	3.683	3.617	3.600	3.558	3.592	3.592	3.675

STANDARD DEVIATIONS WITHIN CLUSTERS OF THREE SAMPLES

LAYER	L F	L C	L B	C F	C C	C B	R F	R C	R B
1	0.050	0.038	0.029	0.088	0.014	0.014	0.025	0.025	0.058
2	0.014	0.029	0.072	0.038	0.038	0.038	0.038	0.014	0.066
3	0.076	0.063	0.066	0.014	0.038	0.063	0.038	0.058	0.075
4	0.029	0.014	0.014	0.029	0.038	0.014	0.038	0.029	0.050
5	0.050	0.025	0.038	0.058	0.075	0.087	0.014	0.050	0.043
6	0.052	0.029	0.029	0.014	0.038	0.050	0.038	0.000	0.029
7	0.050	0.029	0.029	0.029	0.025	0.025	0.029	0.025	0.050
8	0.050	0.050	0.063	0.029	0.000	0.052	0.090	0.101	0.066
9	0.038	0.087	0.014	0.052	0.048	0.066	0.052	0.025	0.052
10	0.050	0.029	0.029	0.113	0.076	0.025	0.029	0.014	0.029
11	0.052	0.014	0.038	0.043	0.000	0.038	0.025	0.043	0.050
12	0.029	0.025	0.038	0.052	0.014	0.038	0.050	0.050	0.014
13	0.030	0.020	0.048	0.025	0.020	0.030	0.025	0.014	0.038
14	0.038	0.063	0.025	0.038	0.014	0.014	0.025	0.029	0.025
15	0.038	0.014	0.043	0.014	0.025	0.038	0.029	0.038	0.038
16	0.066	0.058	0.038	0.029	0.087	0.038	0.113	0.029	0.000

WHERE: LF = Left Front CF = Center Front RF = Right Front
LC = Left Center CC = Center Center RC = Right Center
LB = Left Back CB = Center Back RB = Right Back

TABLE XI BASIC INFORMATION ON EACH BALE IN PROGRAM

Identification Bale Number	Location of Gin Point	Date of Ginning
10	Woodville, California	November 17, 1967
11	McFarland, California	October 27, 1967
12	Buttonwillow, California	November 13, 1967
13	Buttonwillow, California	November 20, 1967
14	McFarland, California	November 10, 1967
15	Pahrump, Nevada	December 14, 1967
16	Wasco, California	November 22, 1967
17	Wasco, California	November 22, 1967
18	McFarland, California	January 22, 1968
19	Bakersfield, California	January 15, 1968
(Note: All Acala SJ-1 except #15 which is Acala 1517)		
20	Marana, Arizona (1)	October 10, 1967
21	Casa Grande, Arizona (2)	November 9, 1967
22	Eloy, Arizona (2)	November 30, 1967
23	Maricopa, Arizona (1)	November 9, 1967
24	Coolidge, Arizona (2)	October 27, 1967
25	Coolidge, Arizona (2)	November 13, 1967
26	11-mi Corner, Arizona (1)	November 14, 1967
27	11-mi Corner, Arizona (1)	November 14, 1967
28	Coolidge, Arizona (2)	November 27, 1967
29	Somerton, Arizona (1)	October 8, 1967
(Note: (1) D & PL (2) Acala 4-42)		
30	Adcock Gin, Dawson County, Texas (1)	January 12, 1968
31	Midway Gin, Dawson County, Texas (1)	May 5, 1967
32	Midway Gin, Dawson County, Texas (1)	December 6, 1967
33	Lamesa Coop Gin, Lamesa, Texas (2)	October 23, 1967
34	Slide Coop Gin, Slide, Texas (3)	October 28, 1967
35	Lamesa Coop Gin, Lamesa, Texas (4)	May 1, 1967
36	McAdoo Coop Gin, McAdoo, Texas (4)	November 12, 1967
37	State Line Coop Gin, Gaines Co.,Texas	November 15, 1967 (4)
38	Seminole Coop Gin, Seminole, Texas (5)	November 18, 1967
39	O'Donnell Coop Gin, O'Donnell, Texas	February 19, 1968 (6)
(Note: (1) Lankart 57 (2) Dun 56C (3) Cockett 4789 (4) Paymaster 111 (5) Acala 1517 (6) Cockett 88A)		
40	Whitney Gin, Whitney, Texas (1)	September 11, 1967
41	Johnson Gin, Penelope, Texas (1)	September 24, 1967
42	Jumper Gin, Idabel, Oklahoma (2)	November 13, 1967
43	Jumper Gin, Idabel, Oklahoma (2)	March 8, 1968
44	Forreston Coop Gin, Forreston,Texas (1)	August 18, 1967
45	Duvall Gin, Midlothian, Texas (1)	August 25, 1967
46	Duvall Gin, Midlothian, Texas (1)	September 19, 1967
47	Groves Gin, Wylie, Texas (1)	August 30, 1967
48	Farmers Coop Gin, Frisco, Texas (3)	August 30, 1967
49	Plano Coop Gin, Plano, Texas (1)	August 28, 1967
(Note: (1) Lankart 57 (2) D & PL (3) Unknown		
50	Dyersburg, Tennessee	November 17, 1967
51	Halls, Tennessee	November 20, 1967
52	Counce, Tennessee	November 16, 1967
53	Rossville, Tennessee	October 27, 1967
54	Collierville, Tennessee	October 25, 1967
55	Byhalia, Mississippi	November 17, 1967

TABLE XI BASIC INFORMATION ON EACH BALE IN PROGRAM (CONTINUED)

Identification Bale Number	Location of Gin Point	Date of Ginning
56	Aberdeen, Mississippi	November 16, 1967
57	Tupelo, Mississippi	October 30, 1967
58	Amory, Mississippi	November 16, 1967
59	Lamar, Mississippi	November 16, 1967
	(Note: Varieties not available)	
60	Cleveland, Mississippi	October 18, 1967
61	Clarksdale, Mississippi	October 19, 1967
62	Belzoni, Mississippi	November 1, 1967
63	Indianola, Mississippi	October 28, 1967
64	Greenwood, Mississippi	October 31, 1967
65	Yazoo City, Mississippi	October 24, 1967
66	Greenville, Mississippi	November 16, 1967
67	Shelby, Mississippi	November 17, 1967
68	Cleveland, Mississippi	November 25, 1967
69	Indianola, Mississippi	December 11, 1967
	(Note: Varieties not available)	
70	Columbia, Alabama (1)	October 1, 1967
71	Columbia, Alabama (1)	October 2, 1967
72	Unreported (2)	September 26, 1967
73	Unreported (2)	September 25, 1967
74	Unreported (2)	November 20, 1967
75	Unreported (3)	unknown
76	Unreported (3)	December 18, 1967
77	Unreported (4)	December 4, 1967
78	Unreported (2)	January 5, 1968
79	Unreported (3)	September 22, 1967
	(Note: (1) Dixie Kine II (2) Coker 100 (3) Unknown (4) McNair	
80	Dawson, Georgia	September 22, 1967
81	Chauncey, Georgia	November 14, 1967
82	Sycamore, Georgia	September 15, 1967
83	Berlin, Georgia	September 11, 1967
84	Funston, Georgia	September 7, 1967
85	Vienna, Georgia	November 25, 1967
86	Berlin, Georgia	September 6, 1967
87	Pine Mountain, Georgia	October 24, 1967
88	Statham, Georgia	November 15, 1967
89	Social Circle, Georgia	November 15, 1967
	(Note: All Carolina Queen)	
90	Bellville, Georgia	November 16, 1967
91	Sylvania, Georgia	December 12, 1967
92	Avera, Georgia	December 13, 1967
93	Wadley, Georgia	January 18, 1968
94	Gough, Georgia	October 13, 1967
95	Warrenton, Georgia	October 10, 1967
96	Alexander, Georgia	September 15, 1967
97	Avera, Georgia	October 23, 1967
98	Thomson, Georgia	October 31, 1967
99	Avera, Georgia	October 21, 1967
	(Note: All Carolina Queen)	

TABLE XII INDIVIDUAL READINGS FOR 64 SAMPLES TAKEN FROM BALE NO. 10

TEST NO.	PRES. ST.	MICR.	50% LGTH	2.5% LGTH	REFLECT.	+B	COLOR	L50/L2.5
100101	106.28	4.65	56.0	118.5	79.4	9.9	106.7	47.3
103301	106.13	4.67	55.5	115.0	80.8	9.9	108.4	48.3
100201	104.90	4.67	55.0	116.0	81.0	9.9	108.0	47.4
103401	103.32	4.70	55.0	115.0	80.8	10.0	108.2	47.8
100301	91.57	4.72	55.0	115.0	80.3	9.9	107.2	47.8
103501	106.16	4.63	55.5	114.5	80.8	9.9	108.1	48.5
100401	107.38	4.67	55.5	117.0	80.8	9.8	107.9	47.4
103601	104.56	4.60	53.5	115.0	80.8	9.8	107.8	46.5
100501	102.58	4.70	52.0	114.0	80.8	9.9	108.0	45.6
103701	105.02	4.75	55.5	118.5	80.3	9.8	107.4	46.8
100601	104.56	4.63	54.5	114.0	80.0	9.9	107.0	47.8
103801	103.51	4.67	55.5	116.0	80.0	9.9	106.7	47.8
100701	104.76	4.65	58.0	117.5	80.4	9.9	107.4	49.4
103901	105.50	4.70	56.0	115.5	80.8	9.8	107.9	48.5
100801	104.01	4.78	56.0	114.5	81.3	9.7	108.2	48.9
104001	100.19	4.75	57.0	119.0	80.7	9.3	107.4	47.9
100901	104.13	4.67	55.0	114.0	80.0	9.4	106.9	48.2
104101	102.22	4.70	57.0	116.5	79.8	9.7	106.6	48.9
101001	102.59	4.80	52.5	113.5	81.2	9.7	108.2	46.3
104201	98.65	4.70	56.5	112.5	80.8	9.8	108.0	50.2
101101	98.73	4.63	54.0	115.5	80.3	9.8	107.3	46.7
104301	106.91	4.72	54.5	115.0	81.3	9.8	108.3	47.4
101201	104.22	4.63	50.5	112.5	81.5	9.7	108.4	44.9
104401	103.44	4.55	50.0	112.5	80.5	9.8	107.6	44.4
101301	98.95	4.65	49.5	111.0	80.3	9.3	106.9	44.6
104501	105.54	4.60	49.0	112.0	81.0	9.4	107.9	43.8
101401	99.85	4.72	50.5	110.0	81.5	9.8	108.7	45.9
104601	104.74	4.70	55.0	115.0	80.8	9.7	108.0	47.8
101501	96.85	4.75	54.5	113.5	81.0	9.8	108.3	48.0
104701	101.41	4.70	57.0	115.0	80.8	9.8	107.8	49.6
101601	105.26	4.72	51.5	112.5	81.5	9.3	108.6	45.8
104801	106.74	4.72	52.0	112.5	80.8	9.9	108.0	46.2
101701	103.00	4.72	51.0	112.5	81.0	9.8	108.3	45.3
104901	103.94	4.75	50.5	114.0	81.0	9.8	108.2	44.3
101801	102.25	4.80	54.0	111.0	79.8	9.8	106.9	48.6
105001	105.06	4.80	53.0	114.5	80.3	9.8	107.6	46.3
101901	102.70	4.72	53.5	111.5	80.5	9.8	107.3	48.0
105101	101.90	4.65	53.0	114.0	81.5	9.8	108.5	46.5
102001	101.51	4.75	56.5	116.5	81.0	9.1	107.8	48.5
105201	100.90	4.72	55.0	115.0	80.6	9.2	107.2	47.8
102101	103.49	4.72	57.0	114.5	81.3	9.1	108.1	49.8
105301	104.01	4.65	56.0	112.5	81.1	9.1	107.6	49.8
102201	103.22	4.67	57.0	117.0	80.8	9.1	107.4	48.7
105401	96.78	4.75	56.5	116.5	81.1	9.1	108.0	48.5
102301	101.80	4.70	58.5	115.5	80.8	9.2	107.8	50.6
105501	102.41	4.67	57.5	115.5	81.0	9.1	107.8	49.8
102401	105.26	4.58	57.0	114.5	80.8	9.1	107.5	49.8
105601	103.98	4.65	54.5	114.0	80.8	9.1	107.5	47.8
102501	93.87	4.72	57.0	117.0	80.8	9.3	107.6	48.7
105701	101.62	4.65	56.5	116.0	81.3	9.1	108.1	48.7
102601	94.30	4.65	58.0	116.5	81.0	9.1	107.7	49.8
105801	101.32	4.60	59.5	116.0	81.0	9.1	107.5	51.3
102701	97.78	4.60	57.5	117.0	80.5	9.6	107.3	49.2
105901	100.91	4.65	54.5	113.5	80.6	9.8	107.9	48.0
102801	102.83	4.60	55.5	112.5	80.8	9.1	107.3	49.3
106001	98.28	4.63	55.5	111.0	79.8	9.7	106.6	50.0
102901	102.07	4.70	57.5	115.0	81.3	9.6	108.4	50.0
106101	96.36	4.58	58.5	114.0	80.8	9.1	107.6	51.3
103001	93.63	4.60	58.5	116.5	81.8	9.1	108.4	50.2
106201	101.24	4.60	57.5	116.0	80.3	9.1	107.1	49.6
103101	102.02	4.72	56.0	110.5	78.8	9.7	104.8	50.7
106301	97.24	4.67	54.0	112.0	80.2	9.9	107.1	48.2
103201	102.49	4.70	59.0	116.0	79.3	9.6	105.4	50.9
106401	95.53	4.70	56.5	114.5	77.5	9.6	102.1	49.3

TABLE XIII AVERAGE RESULTS FOR FAN-HEAD SAMPLES TAKEN FROM BALE NO. 10

	AVERAGES OF SAMPLES FROM BALE NO. 10							
SAMPLES	PRES. ST.	MICR.	50% LGTH	2.5% LGTH	REFLECT.	+B	COLOR	L50/L2.5
64	102.09	4.68	55.1	114.6	80.6	9.6	107.5	48.1
32	101.53	4.69	55.1	114.5	80.6	9.5	107.6	48.1
32	102.66	4.68	55.1	114.6	80.6	9.6	107.5	48.1
16	100.66	4.69	55.1	114.5	80.4	9.6	107.4	48.1
16	103.00	4.67	55.0	114.6	80.8	9.6	107.8	48.0
16	102.39	4.69	55.1	114.4	80.9	9.5	107.7	48.1
16	102.33	4.68	55.2	114.7	80.4	9.5	107.2	48.1
8	101.80	4.69	54.4	114.6	80.6	9.5	107.6	47.4
8	103.19	4.67	54.8	114.8	80.7	9.5	107.7	47.7
8	100.66	4.69	55.0	114.3	80.9	9.5	107.8	48.1
8	101.83	4.69	56.1	115.2	80.6	9.6	107.6	48.7
8	99.53	4.69	55.9	114.5	80.3	9.7	107.2	48.8
8	102.80	4.68	55.3	114.4	80.9	9.7	107.9	48.3
8	104.12	4.68	55.2	114.5	80.9	9.4	107.6	48.2
8	102.83	4.67	54.3	114.2	80.2	9.5	106.8	47.5
4	101.82	4.69	54.8	115.5	80.3	9.6	107.4	47.4
4	103.65	4.69	54.9	115.4	80.7	9.6	107.8	47.5
4	101.01	4.73	54.9	114.3	80.7	9.6	107.7	48.0
4	102.09	4.70	56.0	114.5	80.7	9.7	107.8	48.9
4	97.69	4.67	55.0	114.8	80.4	9.8	107.3	47.9
4	103.97	4.66	54.4	114.3	81.0	9.8	108.2	47.6
4	103.98	4.66	54.5	114.6	81.0	9.4	107.8	47.5
4	101.79	4.63	53.5	113.4	80.4	9.6	107.3	47.2
4	101.77	4.69	54.0	113.6	80.9	9.5	107.9	47.5
4	102.73	4.64	54.8	114.3	80.8	9.3	107.6	47.9
4	100.32	4.66	55.1	114.4	81.0	9.5	107.9	48.2
4	101.57	4.68	56.1	115.9	80.5	9.4	107.5	48.4
4	101.36	4.71	56.8	114.3	80.2	9.6	107.1	49.7
4	101.64	4.69	56.1	114.5	80.7	9.6	107.7	49.0
4	104.26	4.69	55.9	114.4	80.7	9.4	107.4	48.8
4	103.86	4.71	55.0	115.0	79.9	9.5	106.3	47.8

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